Responses to RWQCB Comments on the Revised Final Expanded Treatability Study Work Plan for OU-1 [October 16, 2003]

Comment Number	Comment	Response
1	**Section 1.3 Technology Overview, Paragraph 4:** Regional Board staff agrees with the statement "Groundwater reinjection has not been tested at the field scale at NASA JPL to date. More performance data will be needed to select optimal injection rates and to track changes in the aquifer that may result from the continuous reinjection of treated water." A review of the brief report on Pasadena aquifer test results, conducted during May and June 2001 and submitted by NASA JPL to Regional Board staff on January 7, 2004, indicates that the production wells Windsor, Ventura and Well 52 were pumped and several JPL groundwater monitoring wells were used as observation wells. The test data was interpreted using an analytical groundwater model called Multi Layer Program Unsteady State (MLPU). This model was used to determine hydraulic properties of different aquifer layers. Although the aquifer test provides an estimate of hydraulic properties such as; hydraulic conductivity (K), transmissivity (T), and Storativity (S) in the vicinity of production well field outside the JPL site, it does not provide an estimate of onsite aquifer properties during extraction and injection in the area around the proposed extraction well and the injection well in Operable Unit 1 (OU-1) and the injection wells in OU-3.	Bail/slug tests and rising head tests have been conducted in several JPL monitoring wells (including MW-1, MW-7, MW-8, MW-13, and MW-24) to estimate the hydraulic conductivity (presented in the *Draft Feasibility Study Report for Operable Units 1 and 3: On-Site and Off-Site Groundwater* [Foster Wheeler, 2000]). In addition, two monitoring wells in the vicinity of the proposed treatment area (MW-8 and MW-13) were incorporated into the MLPU model aquifer test, which provided estimates of transmissivity, storativity, and horizontal and vertical hydraulic conductivity. These data were incorporated into a groundwater model developed by Battelle to estimate the ROI and the drawdown/mounding that would result from system operation at the design flowrate. The modeling indicated the injected volume would be captured by the extraction wells and that mounding and drawdown would be minimal (refer to Section 3.0 of the Expanded Treatability Study Work Plan).
	(a) Therefore, a more site-specific determination of aquifer hydraulic properties such as horizontal and vertical K, T, and S is required in the area of the proposed OU-1 extraction well. Additionally, we require several other important aquifer properties such as maximum allowable drawdown, optimum groundwater pumping rate, and the radius of influence (ROI) or the extent of the cone of depression in the OU-1 area using the design-pumping rate for the proposed extraction well. This extraction ROI will be used not only to determine the optimum well spacing between any additional future extraction wells required to prevent downgradient migration of the core of perchlorate plume in the OU-1 area, but also to determine the optimum well spacing between the existing and new hydraulically downgradient and crossgradient monitoring wells	Modeling results presented in the Revised Final Expanded Treatability Study Work Plan will be evaluated/confirmed during aquifer testing and initial operation of Phase I of the expanded treatability study (scheduled for April 2004). Drawdown, optimal pumping rate, ROI, mounding, optimal injection rates, and injection pressure will be determined and reported to the RWQCB, EPA, and DTSC. A letter work plan is provided as Attachment A to elaborate on how these data will be obtained.

Comment Number	Comment	Response
	so that the post-injection groundwater quality can be captured and monitored at these well locations. Furthermore, we require to know the aquifer properties related to the injection of treated effluent into the proposed injection wells at OU-1 and OU-3 such as; the vertical and lateral extent of anticipated mounding at the design injection rate, optimum injection rate and pressure, and optimum well spacing between downgradient and crossgradient monitoring wells necessary to capture and monitor post-injection groundwater quality.	
	(b) You are, therefore, required to perform both a step-drawdown test and a long duration (recommended for at least 5 days) aquifer pumping test in the OU-1 area and injection tests in OU-1 and OU-3 areas. During the pumping test, use the proposed extraction well in OU-1 as the pumping well, and use existing and new monitoring wells as the observation wells located at increasing distances from the pumping well. Similarly, during the long duration injection tests in the OU-1 and OU-3 areas, use the proposed injection wells for injection and existing and new monitoring wells as the observation wells. You are required to submit an aquifer test report containing the test set-up, test procedures, field data, methods used for data analysis, calculations and an interpretation of the results to this Regional Board for review and approval by **May 31, 2004**.	As determined during the teleconference on March 11, 2004, aquifer pumping tests will be performed using the Phase I extraction well. Additional details associated with aquifer testing are provided in Attachment A.
	(c) Before performing the aquifer tests as required in 1(b) above, measure groundwater elevations and collect groundwater samples from all the existing groundwater monitoring wells. Analyze the groundwater samples for VOCs and perchlorate. If these data were collected as a part of on-going quarterly groundwater monitoring of all the wells, then immediately start submitting the quarterly report to the Regional Board according to the following schedule:	Quarterly groundwater monitoring reports are available at the following Web site: http://jplwater.nasa.gov/NMOWeb/. Notifications will be sent to the EPA, DTSC, and RWQCB when new reports are posted on the Web site.

Comment Number	Comment	Response
	<u>Reporting Period</u> **<u>Report Due Date</u>** January-March April 15th April-June July 15th July-September October 15th October-December January 15th The next groundwater monitoring report (for January-March 2004) is due by **April 15, 2004.** The report must contain groundwater elevation contour map and isoconcentration maps for each significant VOC and perchlorate based on quarterly data from all the onsite and offsite groundwater monitoring wells.	
	(d) You are also required to conduct a tracer study and submit a report containing procedures used during the study, field data collected, and interpretation of the results of the study to this Regional Board by **May 31, 2004.** The study will determine and verify the groundwater velocity and flow directions of treated effluent to be injected along with a tracer into the proposed OU-1 and OU-3 injection wells and monitored in the surrounding monitoring well located at increasing distances.	The need for a tracer study will be evaluated based on the results of aquifer testing and initial operation of the treatment system.

Comment Number	Comment	Response
2	Before performing the pumping, injection, and tracer tests as described in comment No. 1 above, you are required to install new multi-port groundwater monitoring wells screened in aquifer layers 1, 2, and 3 at the following locations. After installation of these new monitoring wells, additional monitoring wells may be required if considered necessary by the Regional Board staff. (a) halfway between existing monitoring wells MW-7 and MW-8 in the OU-1 area (b) halfway between wells MW-4 and MW-24 in the OU-1 area (c) approximately 500 feet west of the western-most injection well in the upper row of four proposed injection wells in the OU-3 area (d) 500 feet east-southeast of the eastern-most of the two proposed injection wells in the OU-3 area. (e) The screen intervals to be designed for the new wells must stratigraphically correlate with the soil horizons in the injection wells in which treated groundwater will be injected.	As determined during the teleconference on March 11, 2004, the need for additional monitoring wells will be determined after evaluating results from aquifer testing and initial system operation (i.e., first 3 months). Additional monitoring wells will not be installed prior to initiating Phase I system operation.
3	**Section 2.4, Paragraph 2:** Please also provide to the Regional Board a copy of the data reporting the quantities of water extracted and reinjected into each aquifer layer below the JPL site.	Expanded treatability study operations reports will include quantities of water extracted and reinjected as part of the OU-1 Expanded Treatability Study.

Comment Number	Comment	Response
4	NASA JPL stated in their July 24, 2003 response to our May 8, 2003 comment letter that N-nitrosodimethylamine (NDMA), 1,2,3-trichloroproane (1,2,3-TCP), and vinyl chloride were not detected in previous groundwater monitoring events. Regional Board staff have not received the analytical results of the previous groundwater monitoring events containing the data relevant to the above three chemicals. Therefore, you are required to submit a technical report containing the historical analytical results for these chemicals to the Regional Board by **March 31, 2004**. If our review of the data confirms your statement, you will be permitted to exclude these three analytical parameters from future groundwater monitoring. The analytical method detection and reporting limits for an analyte must be lower than its maximum contaminant level (MCL) / action level concentration.	The requested data are summarized in Attachment B.
5	**Sections 4.2 and 4.3:** The text specifies that the riser of the extraction and injection wells is to be made of Schedule 80 polyvinyl chloride (PVC) and the screen made of wire-wrapped stainless steel. However, the Tables 4-1 and 4-2 do not include a column for the stainless steel screen, and the column heading "Casing Depth" needs to be changed to Well Depth, and "Casing Material" needs to be changed to "Riser Material." To assure the long-term integrity and ability to resist chemical action in the saturated zone, Regional Board staff recommends the use of stainless steel risers in the submerged portions of the proposed extraction and injection wells. We recommend that you include a sounding tube and a gravel fill tube in the design of each extraction and injection well to facilitate measurement of groundwater levels in a non-turbulent environment. This may make it easier in the future to perform well maintenance after potential clogging of the screen intervals.	The revised well construction materials consist of a stainless steel screen and a carbon steel riser. The revised figures are provided in Attachment C. The need for sounding tubes as part of additional injection/ extraction well installations will be determined during implementation of the Phase I system.
6	**Figure 4-2:** We suggest that you also install a pressure gauge to measure injection pressure and a totalizer to measure the volume of water injected at the well head of each injection well. The injection pressure measurement will help in a timely detection of abnormal backpressures during injection. Also, install a totalizer at the well head of each extraction well to measure the volume of groundwater extracted.	Pressure gauges and totalizers are included in the final well design. The piping and instrumentation diagram (P&ID) is provided in Attachment C.

Comment Number	Comment	Response
7	**Section 4.4:** Include the existing wells: MW-7, MW-11, MW-12, MW-24, MW-8, MW-3, MW-16, MW-13, MW-4, MW-22, MW-14, MW-5, MW-6, MW-23, and the new monitoring wells in your monthly groundwater monitoring program.	As determined during the teleconference on March 11, 2004, monthly monitoring of MW-7, MW-8, MW-11, MW-13, MW-16, and MW-24 will be conducted. The additional monitoring wells identified in the subject comment will continue on a quarterly schedule as part of the groundwater monitoring program. However, monthly results will be closely evaluated to determine if additional wells should be monitored. Also, pressure transducers will be used to collect water level data from MW-7, MW-8, MW-11, MW-13, MW-16, and MW-24 daily during the first 6 months of system operation.
8	**Section 4.4:** Provide an estimate for the duration of the expanded treatability study.	The duration of Phase I of the expanded treatability study is 6 months to 1 year. The overall duration of system operation in OU-1 is not currently known; however, it will likely be decades. Data collected during Phase I of the expanded treatability study should help estimate the duration of full-scale operation.
9	Submit a copy of the manufacturer's Operation and Maintenance (O&M) manual to Regional Board staff before starting up the system. Maintain complete records of field data onsite for possible inspection by the State and/or Federal regulatory agencies.	An O&M manual will be provided to the RWQCB. Complete records of field data will be maintained onsite.
10	**Section 4.6.3:** How long will the perchlorate-contaminated groundwater be in contact with the degrading microorganisms in the fluidized bed reactor (FBR)? Has NASA-JPL determined the contact time required for this reduction from previous studies at this site or other sites?	The FBR will have a superficial hydraulic contact time of approximately 21.3 minutes. This is the time that the average influent water is in contact with the carbon media inside the reactor. However, this is not the parameter which is critical for design or treatment removal efficiency determination. The total organic carbon (TOC) loading rate to the carbon bed is the critical design parameter. The system is designed for a TOC mass loading of 0.49 kg TOC/ m^3 of carbon/day. The nominal design values range from 0.3 to 0.6 for this parameter. The pilot testing for the OU-1 system was operated at this design load and the performance determinations were made at that loading. This design load has also been applied to several other treatment systems for perchlorate removal including the Aerojet facility in which the effluent has been evaluated for meeting drinking water perchlorate requirements.

Comment Number	Comment	Response
11	**Section 2.2 and Section 2.3:** This Regional Board's General Waste Discharge Requirements (WDR) (Order No. R4-2002-0030) is applicable only to groundwater contaminated with petroleum hydrocarbons and volatile organic compounds (VOCs), and not applicable to dissolved heavy metals and inorganic chemicals such as perchlorate. Therefore, reference to the above WDR should be removed from the subject document.	Comment noted. WDR Order No. R4-2002-0030 does not apply.
12	**Table 2-1:** Change "Applicable Limits For Treated Water" in Table 2-1 from "None" to 4 and 3 µg/L respectively for perchlorate and 1,4-dioxane. As stated in our comment letter dated May 8, 2003, **these concentrations are the California Department of Health Services (CADHS) action levels for perchlorate and 1,4-dioxane, and are considered by the Regional Board to be applicable cleanup levels for the treated effluent from the Fluidized Bed Reactor (FBR) and Multimedia Filter. Only the treated effluent meeting these cleanup levels would be injected into the aquifer screened in the proposed OU-1 and OU-3 injection wells.** Actually, CADHS and the area water purveyor have required the cleanup of FBR-treated groundwater to non-detectable levels before its injection in the OU-1 and OU-3.	Concur.
13	**Section 5.0, Reduce Chemical Concentrations in Test Area Monitoring Wells:** In the sentence "The objective of this criterion is to achieve significant reduction of chemical levels in the test area." Please include: reduction to conform with the State of California maximum contaminant levels or action levels.	Concur.
14	**Table 5-2:** Include an analysis of treated effluent samples for proprietary microbes 5 times per week at the Multimedia Filter Outlet.	The inoculums used for the perchlorate treatment are not proprietary; rather, they are cultured from other nonpathogenic sources. Since the OU-1 treatment facility does not include unit operations for disinfection, there will be microorganisms present in the discharge from the facility. However, these microorganisms are not pathogenic and actual testing at other perchlorate treatment systems have determined that the effluent pathogenic organism levels meet drink water standards.

Comment Number	Comment	Response
15	**Section 5-2:** Change the sentence "The FBR will be operated in recycle mode during this period until it can be demonstrated that adequate nitrate and ClO_4^- has been achieved." to include "until it can be demonstrated by the analytical results of the system effluent samples that contaminants including nitrate and ClO_4^- have been reduced to approved cleanup levels."	Concur.
16	**Section 5.4.2:** You stated "Once steady-state conditions have been reached, the sample collection frequencies listed in Table 5-2 may be reduced." Please be advised that any changes in sample collection and analysis frequencies during performance and compliance monitoring for the treatment system will have to be approved by Regional Board staff.	Comment noted.

ATTACHMENT A

OU-1 Expanded Treatability Study Aquifer Testing Work Plan

The hydraulic characteristics of the aquifer beneath JPL in the vicinity of the study area will be evaluated by performing aquifer tests at each injection and extraction well installed during Phase 1 of the OU-1 removal action. The goal is to collect data for estimating the transmissivity, hydraulic conductivity, and storativity of the aquifer material. Two types of aquifer tests will be conducted using the extraction and injection wells: slug/bail tests and pumping tests. Slug/bail tests will be conducted at each injection (IW-1 and IW-2) and extraction (EW-1 and EW-2) well and an aquifer pumping test will be performed in the deep extraction well (EW-2). A brief description of the methodology that will be implemented to perform these aquifer tests is provided below.

Slug/Bail Tests. Each of the injection and extraction wells will be subjected to in-situ slug/bail tests performed by displacing a quantity of water and monitoring the recovery of the groundwater level to static conditions. The approach for conducting the aquifer tests is similar to that used during completion of slug/bail tests on JPL monitoring wells as outlined in the Final RI for OU-1 and OU-3 (Foster Wheeler, 1999). It should be noted that slug/bail tests are useful in determining the characteristics of a small volume of aquifer material surrounding the well and that this volume may have been disturbed during drilling and construction, thus affecting the results of the test. Slug/bail tests are designed to monitor the relationship between groundwater-level elevations and time in each of the newly installed wells and are designed to provide a preliminary estimate of aquifer conditions. This relationship is indicative of how quickly water can be transported from the well to the adjacent formation or from the formation to the well. The data collected from these tests, in combination with the well completion information, will be used to estimate the hydraulic conductivity of the aquifer material in the proximity of each well screen.

For purposes of water displacement, a 15-ft section of 5-inch outer diameter Schedule 80 PVC casing with threaded end caps will assembled and used. Depending on the data generated after the initial use, the size of the slug casing can be modified to allow for more or less water displacement. Prior to testing, the casing will be filled with deionized water to increase its weight to assure submergence beneath the groundwater table. The casing will be carefully assembled to prevent leakage into the wells.

Prior to conducting each slug/bail test, the depth to water will be measured using a groundwater-level indicator probe. The probe will be thoroughly decontaminated between each well. Once the groundwater level is measured, a pressure transducer probe will be lowered into the well and fixed at a depth below the static water level at an elevation sufficiently lower than the depth to which the casing slug is expected to descend. The pressure transducer probe will be connected to a data logger to record measurements taken by the pressure transducer during the tests. The data logger will record water pressure that reflects the height of the water column above the transducer probe. The water displacements in the wells will be obtained by calculating the deviations from the static water height.

During the tests, a cable will be attached to the slug casing and the casing will be lowered and raised into and out of the wells using a hydraulic winch. During the "slug" portion of the test, the casing will be initially lowered to near the top of the static groundwater level in the test well. Upon initiating the test, the casing will be quickly lowered into the well and submerged under water. Care will be taken not to submerge the casing too quickly, thereby minimizing splashing and severe oscillations of the static groundwater level. This abrupt submergence of the casing will result in a rise in the groundwater level that will be recorded as a rise in pressure by the pressure transducer. Subsequently, the groundwater level will gradually recover to the static groundwater level and the recovery will be recorded by the data logger at specified time intervals. The groundwater-level data will be used to provide a relationship for groundwater level displacement with time.

Once the static groundwater level has been stabilized, the aquifer test will be repeated in each well in the form of a "bail" test. During this portion of the test, the casing will be rapidly raised out of the water column in the well and the data logger will record the groundwater level displacement. Sudden removal of the casing will result in an initial decline in the groundwater level in the test well, simulating the removal of water from the well with a bailer. Subsequently, the groundwater level will gradually recover to the static level and the recovery will be recorded by the data logger at specified time intervals.

Data collected during development (i.e., purging) of the extraction/injection wells indicate the groundwater level will recover fairly quickly after insertion/removal of the casing and therefore these tests will be able to be carried out in rapid succession. As a result, three separate slug/bail tests will be performed in each injection and extraction well to provide a measure of parameter variability of aquifer materials.

Groundwater-level data collected during the slug/bail tests will be used in conjunction with well completion data (Table 1) to estimate the hydraulic conductivity of the aquifer immediately surrounding the test well. The hydraulic conductivity will be estimated using the methods developed by Bouwer and Rice (1976), which are applicable to situations involving partially penetrating wells in unconfined or semi-confined aquifers, consistent with the general conditions encountered in the shallow monitoring wells at the JPL site. The aquifer design and test software program AQTESOLV® (Gerraghty and Miller, 1991) will be used to implement the Bouwer and Rice (1976) method and estimate hydraulic conductivity values.

Table 1. OU-1 Removal Action Well Construction Summary

Well	Depth (ft bgs)	Screen Depth (ft bgs)	Diameter (in)	Slot Size	Depth to Groundwater (ft bgs)	Design Extraction Rate (gpm)
EW-1 (shallow)	265	215-265	6	0.040	170	50
EW-2 (deep)	315	265-315	6	0.040	170	125
IW-1	315	215-315	6	0.050	214	NA
IW-2	315	215-315	6	0.050	221	NA

Pumping Test. To supplement the information obtained from the slug/bail tests, and in order to get potentially more applicable aquifer hydraulic parameters, a full-scale aquifer pumping test will be conducted in the deep extraction well (EW-2). As noted in Table 1, EW-2 has a 50-ft screened interval and a design extraction rate of 125 gpm. The pumping test will be performed to determine well production, drawdown, and well efficiency relationships at the specified extraction rate. Data collected during this test also will be used to estimate aquifer transmissivity, hydraulic conductivity, and storativity in the area of influence, and specific capacity of the pumping well. The approach for conducting the pumping test will be similar to that used during the large-scale aquifer test conducted in City of Pasadena Production wells (NASA, 2003).

Following installation of EW-2, the well was extensively developed to remove residual drilling mud and formational fines from the water column. The last stage of the development process, which was designed to purge remaining fines and test well efficiency, included intermittently extracting groundwater from the well at a rate at or slightly above 80 gpm for a period of three hours. During pumping, the groundwater level in the well stabilized fairly quickly (approximately 10 minutes) at approximately 10 ft below the static level for each extraction interval. When the pump was turned off, groundwater levels rebounded to static conditions within 15 minutes. Based on the current well construction, the available drawdown (>100 ft) in the well, the high permeability of aquifer materials, and the high pumping rates achieved in other Monk Hill production wells, it is very likely that the design extraction rate (125 gpm) will easily be achieved with minimal drawdown.

Because the well efficiency and pump sizing has already been determined, and due to the likelihood that fluctuations in groundwater levels in the surrounding observations wells will be minimal at low extraction rates, a constant rate aquifer test will be implemented at an extraction rate of 150 gpm, which is slightly above the design rate. Although it is expected that drawdown in the deep extraction well will stabilize fairly quickly, the constant-rate pumping rate test will be performed for a period of 8 hours to more effectively test the production capacity of the well and allow for stabilization of groundwater levels within the resulting cone of depression. The groundwater level (pressure) in the well will be monitored using a pressure transducer that is installed a sufficient distance beneath the pump intake. Data will be recorded using a data logger that is attached to the transducer cable.

Based on the proposed extraction rate, it is estimated that approximately 72,000 gallons of purge water will be generated during the aquifer test. The extracted groundwater (investigation-derived waste [IDW]) will be temporarily stored on-site in four 21,000 gallon Baker tanks. As recommended by the EPA during the March 11, 2004 teleconference, the first option for disposal of IDW will be reinjection back into the extraction well. If reinjection is not a viable disposal option, the IDW will be characterized and disposed of in accordance with the IDW disposal procedures outlined in the Final RI for OU-1 and OU-3 (Foster Wheeler, 1999).

A recovery test will be conducted immediately following cessation of the constant rate pumping test. This test is designed to measure the rise in water depth with time once pumping has stopped. The pressure transducer will be left in the test well to continuously monitor the groundwater-level (pressure) changes. The recovery test will be conducted for a period of eight hours or until groundwater levels have stabilized to pre-pumping (static) conditions, whichever comes first. In general, data obtained during the recovery period are more reliable than those collected during the pumping test due to the lack of groundwater-level fluctuations caused by variations in the pumping rate (Roscoe Moss Company, 1990; Fetter, 1993).

During the two pumping tests, the groundwater level (pressure) in six nearby monitoring wells (MW-7, MW-8, MW-11 [screen 1], MW-13, MW-16, and MW-24 [screen 1], the shallow extraction well (EW-1), and the two injection wells (IW-1 and IW-2) will be continuously monitored for resulting changes using pressure transducers deployed in each well at a level below which the groundwater level is not expected to drop. Table 2 summarizes the spatial relationship of these wells with respect to EW-2. Changes in the static groundwater level will be recorded with a data logger for the entire duration of the pumping and recovery test and used in conjunction with extraction well flow rates and groundwater levels to estimate aquifer parameters. Coordination with the groundwater monitoring contractor will be necessary to ensure that the Westbay® monitoring wells (MW-11 and MW-24) are monitored accordingly and that the aquifer test does not interfere with the quarterly monitoring of these wells.

The aquifer design and test software program AQTESOLV® (Gerraghty and Miller, 1991) will be used to estimate aquifer parameter values using groundwater level and time data collected during the constant rate pumping test and the recovery test.

Table 2. Summary of Observation Wells used in Aquifer Test

Well ID	Approximate Distance from EW-2 (ft)
EW-1 (shallow)	12
MW-24	160
MW-7	240
IW-2	345
IW-1	365
MW-8	370
MW-16	513
MW-13	670
MW-11	738

References

NASA. 2003. *Final JPL Groundwater Monitoring Report*. Prepared for the National Aeronautics and Space Administration Jet Propulsion Laboratory. December.

Bouwer, H. and R.C. Rice. 1976. *A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells*. Water Resources Research, Vol. 13, No. 3. June.

Gerraghty and Miller. 1991. *AQTESOLV®, Aquifer Test Design and Analysis Computer Software, Version 1.1*. Gerraghty and Miller, Inc. Modeling Group. Reston, VA.

Fetter, C.W. 1993. *Applied Hydrogeology*, Second Edition. Merrill. Columbus. 592 p.

Foster Wheeler. 1999. *Final Remedial Investigation Report for Operable Units 1 and 3: On-Site and Off-Site Groundwater*. Prepared for the National Aeronautics and Space Administration Jet Propulsion Laboratory. August.

Roscoe Moss Company. 1990. Handbook *of Groundwater Development*. John Wiley and Sons, New York. 493 p.

ATTACHMENT B

Summary of Vinyl Chloride, 1,2,3-Trichloropropane, and NDMA in JPL Monitoring Wells MW-7, MW-16, and MW-24

Vinyl Chloride

- California MCL = 0.5 µg/L
- Reporting limit = 0.5 µg/L
- Not detected above reporting limit in any well in any JPL monitoring event
- Not detected above reporting limit in any well during January 2003 Comprehensive JPL groundwater monitoring event.

1,2,3-TCP

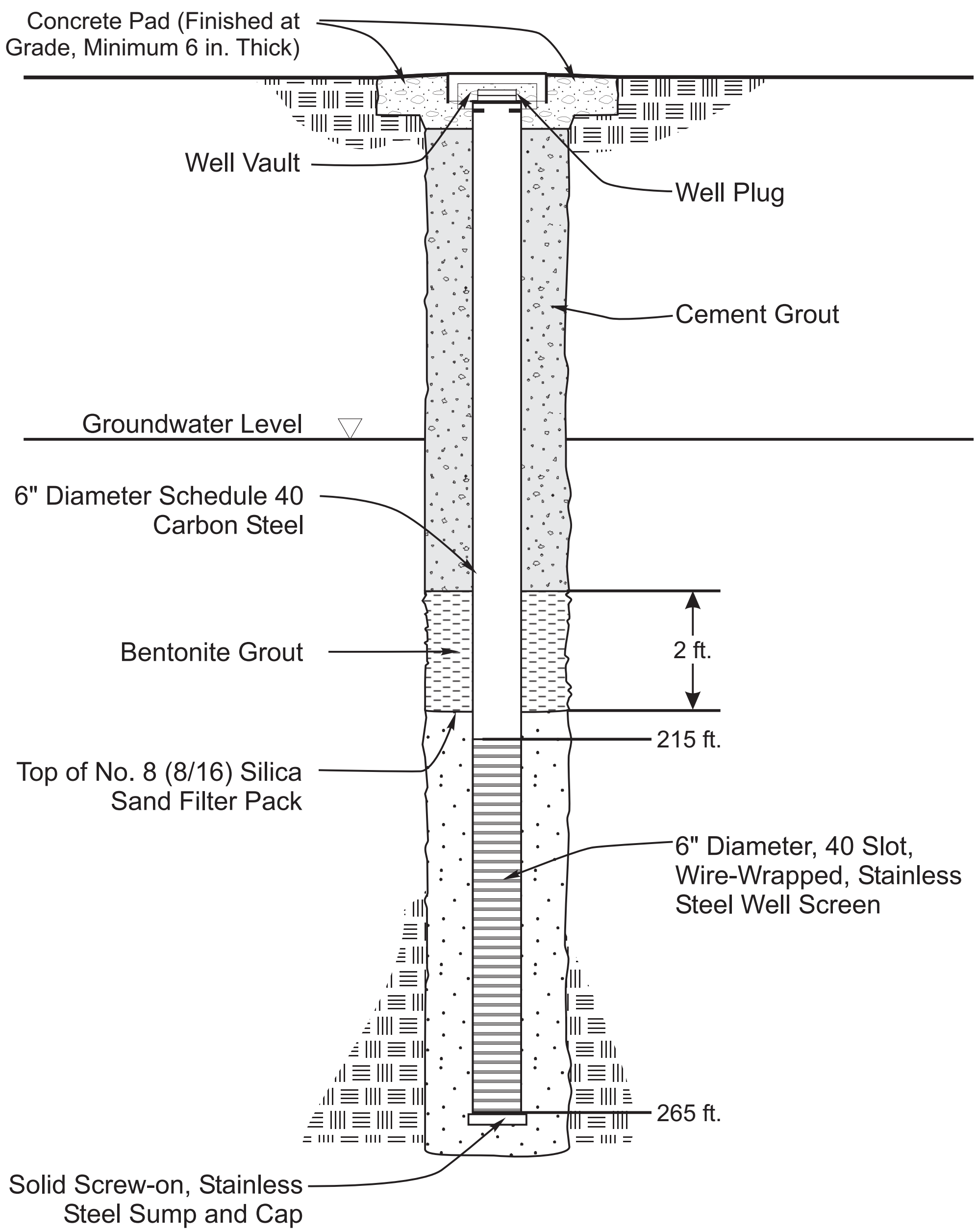
- DHS Action level = 0.005 µg/L
- Reporting limit during JPL quarterly groundwater monitoring events = 0.5 µg/L
    - Analyzed in 20 monitoring events (July 03, Jan 03, Nov 02, Jan 01, Oct 00, Jul 00, Mar 00, Dec 99, Aug 99, May 99, Feb 99, Oct 98, July 98, Apr 98, Jan 98, Sep 97, Jun 97, Feb 97, Oct 96, Aug 96)
    - Not analyzed in 5 monitoring events (Jul 02, Jan 02, Apr 02, Oct 01, Jul 01)
    - Not detected above reporting limit when it was analyzed for in any well
- Reporting limit during January 2003 Comprehensive JPL monitoring event = 0.005 µg/L
    - Not detected in MW-7, MW-16, or MW-24.

NDMA

- DHS action level = 0.01 µg/L
- Not analyzed prior to April 1998
- Reporting limit in April 1998 = 0.005 µg/L
    - Not detected in MW-7, MW-16, or MW-24 (screen 1)
- Reporting limit in July 1998, October 1998, February 1999 = 0.03 µg/L
    - Not detected in MW-7, MW-16, or MW-24 (screen 1)
- Reporting limit in July 2000 = 0.002 µg/L
    - Not detected in MW-7, MW-16, or MW-24 (screen 1)
- Reporting limit in January 2001 = 0.00027 µg/L
    - Not detected in MW-16 or MW-24 (screen 1)
    - Not analyzed in MW-7
- Reporting limit in January 2002 = 0.002 µg/L
    - Not detected in MW-7, MW-16, or MW-24 (screen 1)
- Reporting limit in April 2003 = 0.0002 mg/L
    - Not detected in MW-16 or MW-24 (screen 1)
    - Not analyzed in MW-7
- Reporting limit during January 2003 Comprehensive JPL monitoring event = 0.0023 µg/L
    - Detected in MW-7 at a concentration of 0.00366 µg/L (below the DHS action level).
    - Not detected in MW-16 or MW-24 (screen 2)

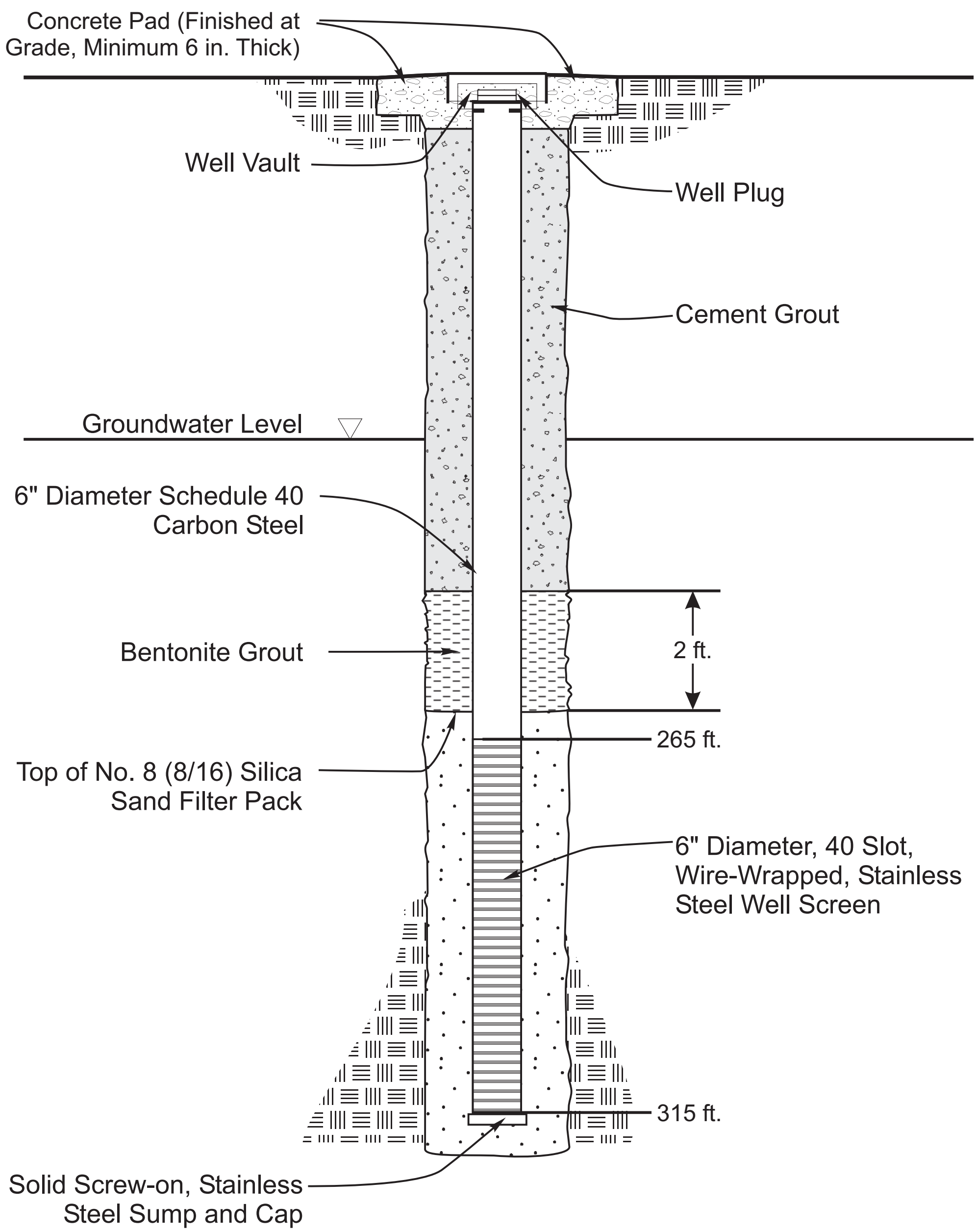
ATTACHMENT C

Revised Well Construction Diagrams
Piping and Instrumentation Diagrams for Extraction/Injection Wells



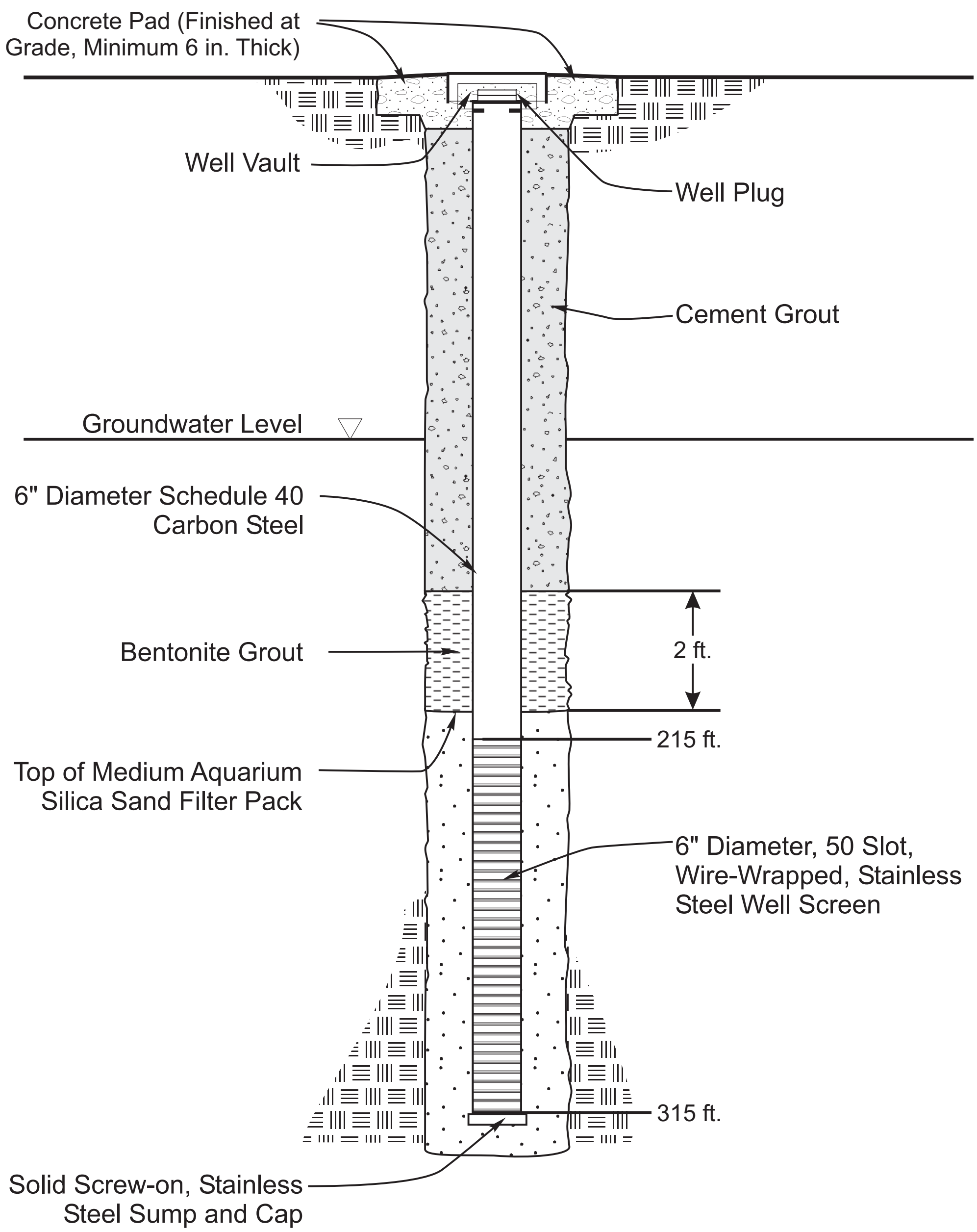
Not to Scale

DESIGNED BY WC	Battelle		
DRAWN BY LC	**EW-1 Well Construction Details**		
CHECKED BY LS	JET PROPULSION LABORATORY, PASADENA, CA		
	PROJECT G486009-T7	EW-1_CD.CDR	DATE 03/04



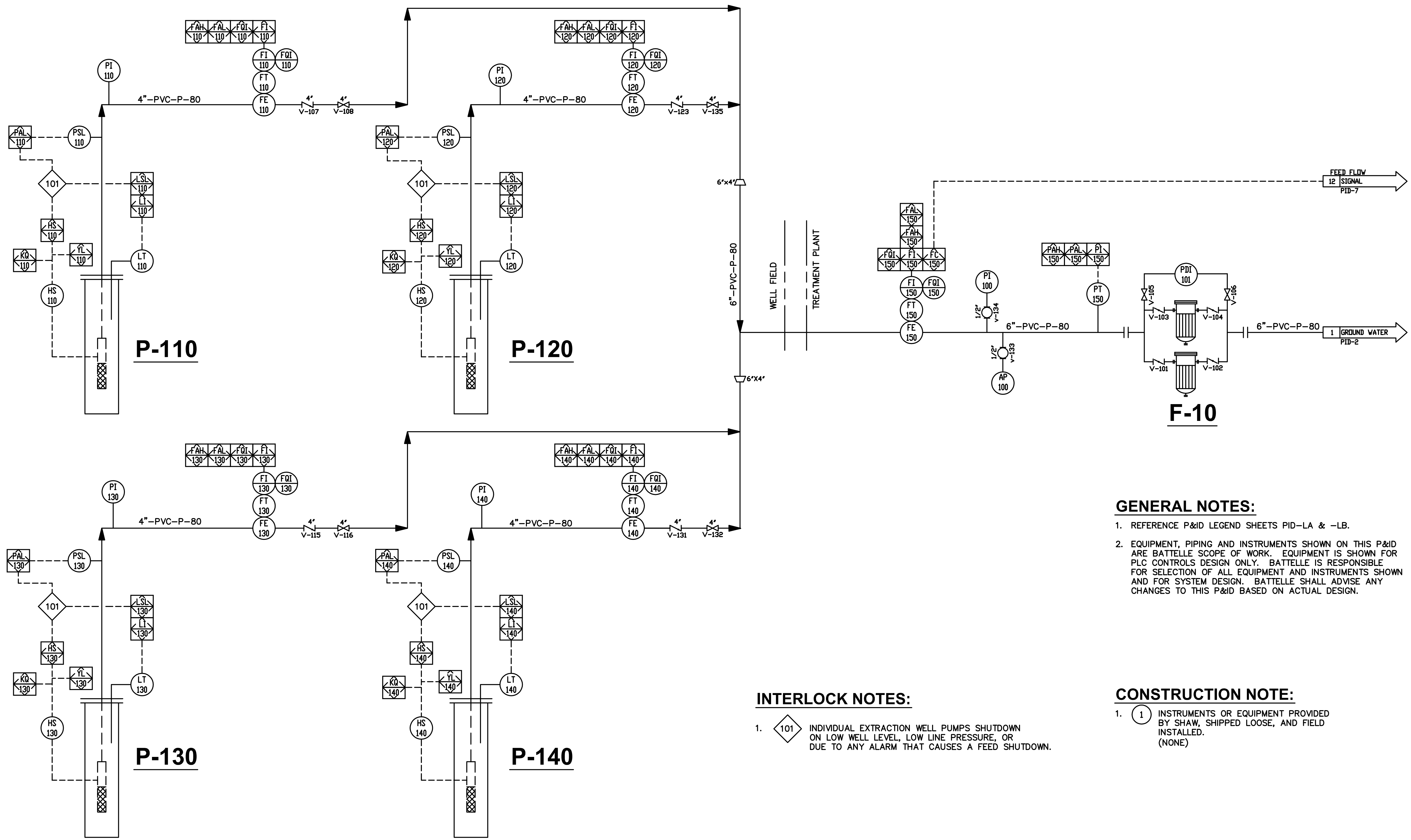
Not to Scale

DESIGNED BY WC	Battelle		
DRAWN BY LC	**EW-2 Well Construction Details**		
CHECKED BY LS	JET PROPULSION LABORATORY, PASADENA, CA		
	PROJECT G486009-T7	EW-2_CD.CDR	DATE 03/04



Not to Scale

DESIGNED BY WC	Battelle		
DRAWN BY LC	**IW-1,2 Well Construction Details**		
CHECKED BY LS	JET PROPULSION LABORATORY, PASADENA, CA		
	PROJECT G486009-T7	IW-1N2_CD.CDR	DATE 03/04



GENERAL NOTES:

1. REFERENCE P&ID LEGEND SHEETS PID-LA & -LB.
2. EQUIPMENT, PIPING AND INSTRUMENTS SHOWN ON THIS P&ID ARE BATTELLE SCOPE OF WORK. EQUIPMENT IS SHOWN FOR PLC CONTROLS DESIGN ONLY. BATTELLE IS RESPONSIBLE FOR SELECTION OF ALL EQUIPMENT AND INSTRUMENTS SHOWN AND FOR SYSTEM DESIGN. BATTELLE SHALL ADVISE ANY CHANGES TO THIS P&ID BASED ON ACTUAL DESIGN.

INTERLOCK NOTES:

1. 101 INDIVIDUAL EXTRACTION WELL PUMPS SHUTDOWN ON LOW WELL LEVEL, LOW LINE PRESSURE, OR DUE TO ANY ALARM THAT CAUSES A FEED SHUTDOWN.

CONSTRUCTION NOTE:

1. 1 INSTRUMENTS OR EQUIPMENT PROVIDED BY SHAW, SHIPPED LOOSE, AND FIELD INSTALLED. (NONE)

LAST VALVE # USED 135

P-110/120/130/140 EXTRACTION WELL PUMP	F-10 BAG FILTER
TYPE: SUBMERSIBLE PUMP CAPACITY: 80 G.P.M. @300' TDH MAT'L: 316 S.S. MOTOR: 10 HP, 460VAC, 3PH, 60HZ	TYPE: DUPLEX BAG FILTER CAPACITY:

REV	DATE	DESCRIPTION OF REVISION	REVISED BY	CHECKED
2	02-25-04	REVISED PER BATTELLE AND SHAW REVIEW	LJ	
1	02-06-04	INCORPORATED BATTELLE COMMENTS	LJ	SF
0	01-26-04	ISSUED FOR CONSTRUCTION	LJ	HS/RL
A	11-18-03	ISSUED FOR REVIEW AND COMMENT	LJ	HS/RL

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DESIGNED BY/DATE SF/11-07-03
DRAWN BY/DATE LJ/11-11-03
CHECKED BY/DATE HS
SHEET SIZE D
REVISION 2
SHEET 1 OF 8
DRAWING # PID-1
FILE # 100770PID01-2

NASA-JET PROPULSION LABORATORY
OU-1 TREATMENT SYSTEM, PASADENA, CA

PIPING & INSTRUMENTATION DIAGRAM EXTRACTION WELLS

SHAW PROJECT# 100770

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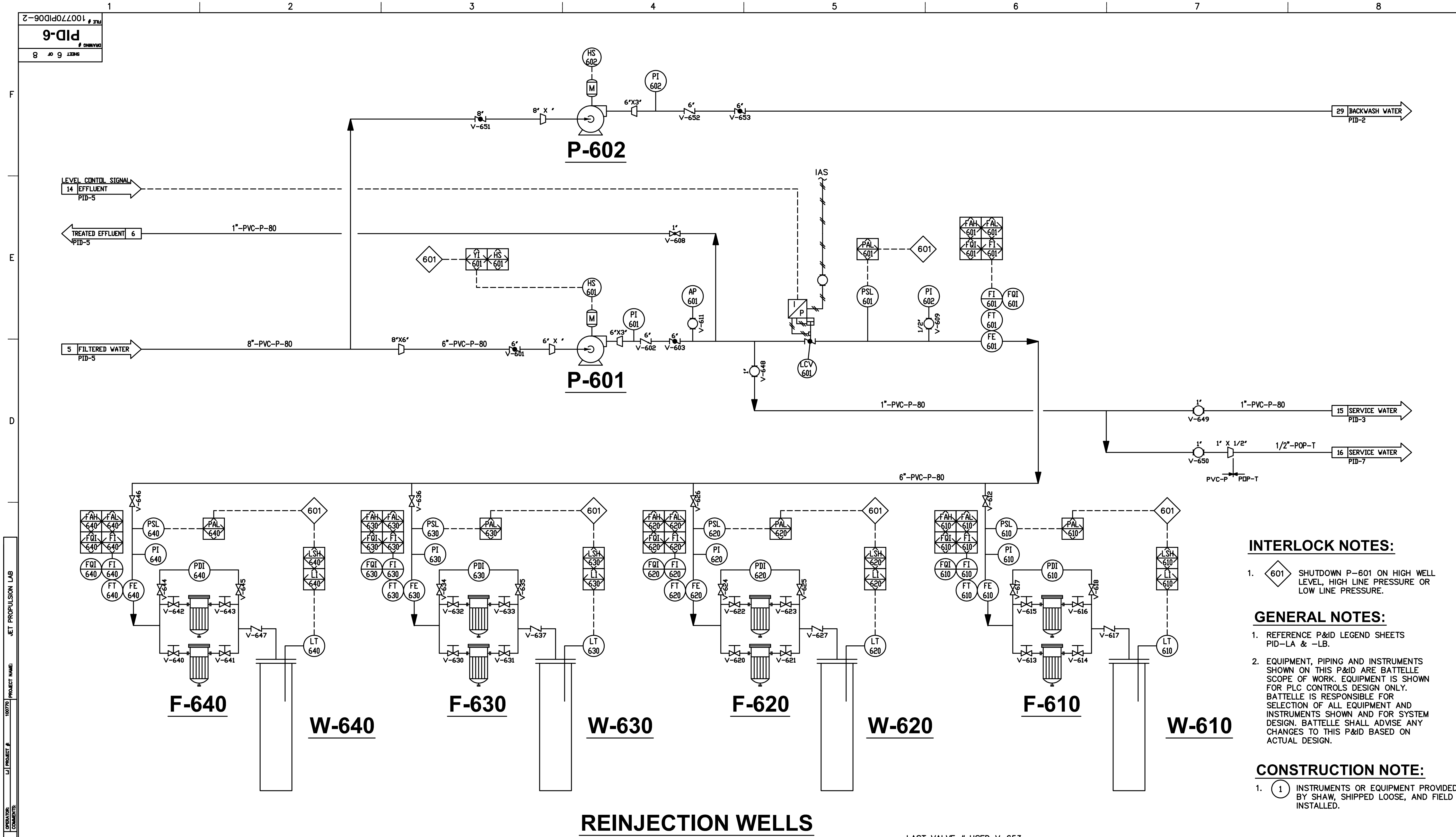
Shaw
Shaw Environmental, Inc.
Lawrenceville, N.J. 609-936-9300

LAST EDITED: 02-23-04 LAWRENCEVILLE, NJ OPERATOR: COMMENTS: LJ PROJECT #: 100770 PROJECT NAME: JET PROPULSION LAB

SHEET 1 OF 8 DRAWING # PID-1 FILE # 100770PID01-2



INTERLOCK NOTES:

1. 601 SHUTDOWN P-601 ON HIGH WELL LEVEL, HIGH LINE PRESSURE OR LOW LINE PRESSURE.

GENERAL NOTES:

1. REFERENCE P&ID LEGEND SHEETS PID-LA & -LB.
2. EQUIPMENT, PIPING AND INSTRUMENTS SHOWN ON THIS P&ID ARE BATTELLE SCOPE OF WORK. EQUIPMENT IS SHOWN FOR PLC CONTROLS DESIGN ONLY. BATTELLE IS RESPONSIBLE FOR SELECTION OF ALL EQUIPMENT AND INSTRUMENTS SHOWN AND FOR SYSTEM DESIGN. BATTELLE SHALL ADVISE ANY CHANGES TO THIS P&ID BASED ON ACTUAL DESIGN.

CONSTRUCTION NOTE:

1. (1) INSTRUMENTS OR EQUIPMENT PROVIDED BY SHAW, SHIPPED LOOSE, AND FIELD INSTALLED.

REINJECTION WELLS

LAST VALVE # USED V-653

P-601 REINJECTION PUMP	P-602 GAC BACKWASH PUMP	F-610/620/630/640 BAG FILTERS	W-610/620/630/640 REINJECTION WELLS
TYPE: CENTRIFUGAL CAPACITY: 350 GPM @ 80' TDH WETTED MAT'L: CAST IRON MOTOR: 15 HP, 460V, 3pH, 60HZ MODEL: VERIFLOW 4X3X10	TYPE: CENTRIFUGAL CAPACITY: 780 GPM @ 70' TDH MOTOR: 25 HP, 460V, 3pH, 60HZ MODEL: VERIFLOW	TYPE: DUPLEX BAG FILTER CAPACITY:	

REV	DATE	DESCRIPTION OF REVISION	REVISED BY	CHECKED
4	02-25-04	REVISED PER BATTELLE AND SHAW REVIEW	LJ	
3	02-09-04	INCORPORATED BATTELLE COMMENTS	LJ	SF
2	01-26-04	ISSUED FOR CONSTRUCTION	DAP	HS/RL
1	11-18-03	ISSUED FOR REVIEW AND COMMENT	DL	SF

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DRAWN BY/DATE LJ/11-12-03
CHECKED BY/DATE HS'11-12-03
SHEET SIZE D REVISION 2
SHEET 6 OF 8
DRAWING # PID-6
FILE # 100770PID06-2

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PIPING & INSTRUMENTATION DIAGRAM
REINJECTION WELLS

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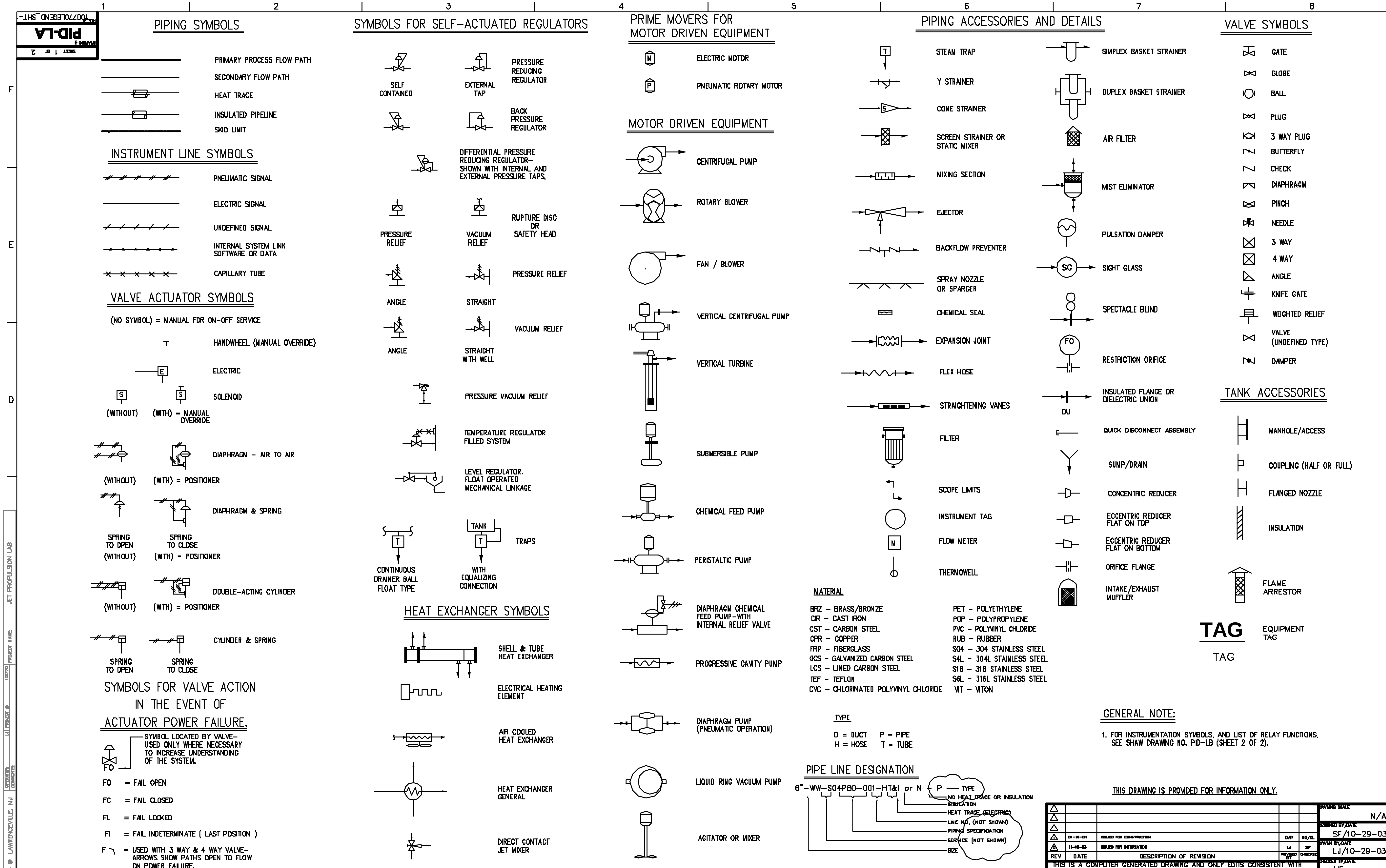
PID-6 SHEET 6 OF 8 FILE # 100770PID06-2



GENERAL NOTE:

1. FOR INSTRUMENTATION SYMBOLS, AND LIST OF RELAY FUNCTIONS, SEE SHAW DRAWING NO. PID-LB (SHEET 2 OF 2).

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B	01-26-04	ISSUED FOR CONSTRUCTION	DAP	WG/AL
A	11-46-03	ISSUED FOR INFORMATION	LJ	SF

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PIPING & INSTRUMENTATION DIAGRAM
LEGEND SHEET
SHAW PROJECT# 100770

SHEET SIZE: D
REVISION: 1
SHEET 1 OF 2
DRAWING #: PID-LA
FILE #: 100770LEGEND_SHT

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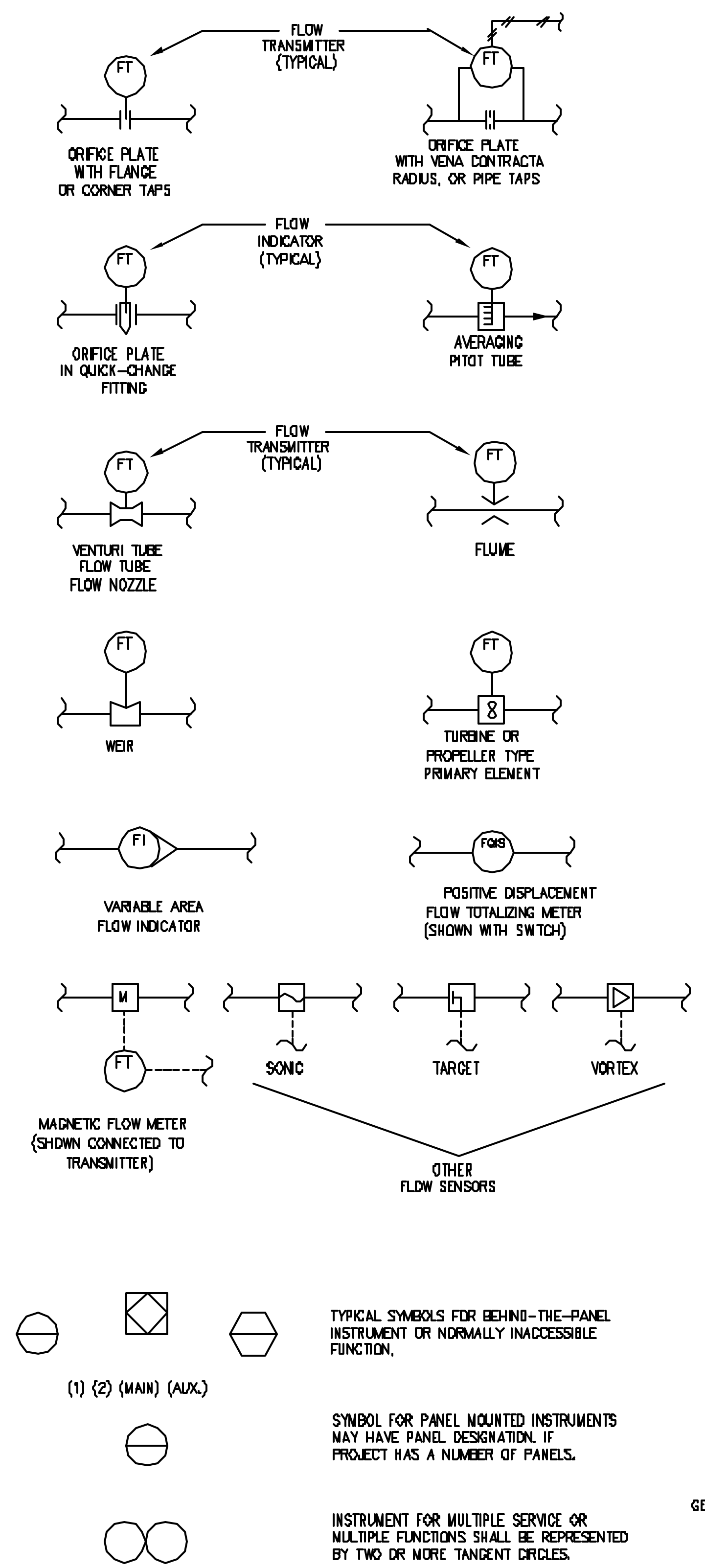
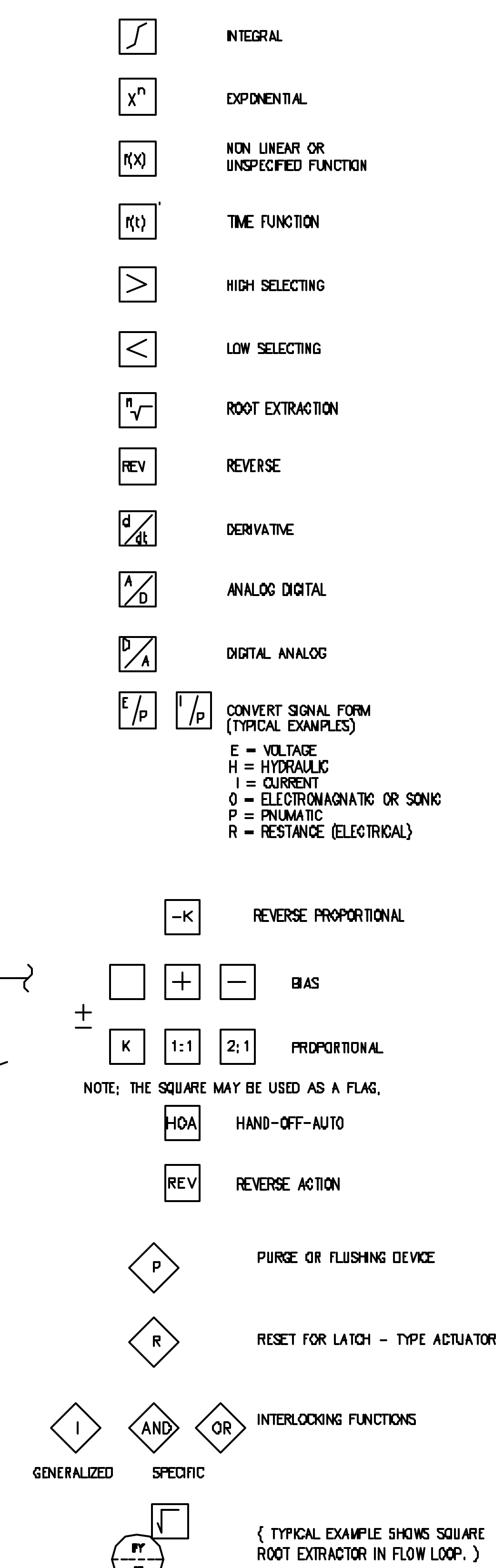
PROJECT #: 100770
PROJECT NAME: JET PROPULSION LAB

SYMBOLS FOR FLOW MEASUREMENT



MISCELLANEOUS SYMBOLS

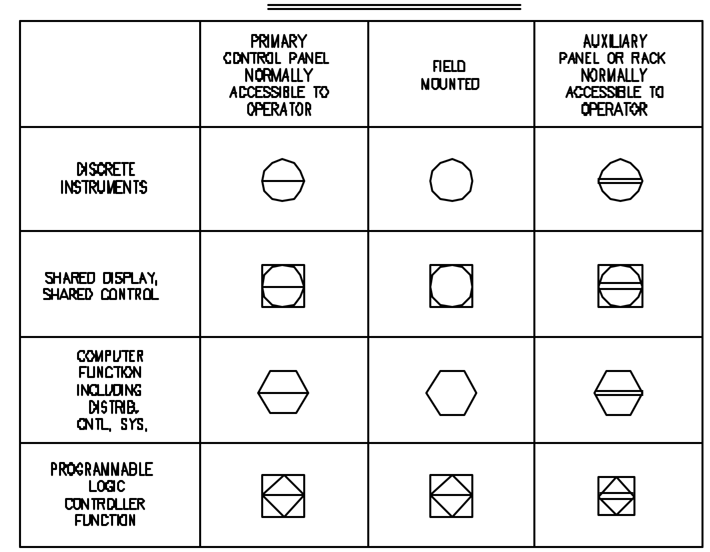


INSTRUMENT IDENTIFICATION LETTERS

FIRST LETTER		SUCCEEDING LETTERS		
MEASURE OR INATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A = ANALYSIS		ALARM		
B = BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C = USER'S CHOICE			CONTROL	
D = USER'S CHOICE	DIFFERENTIAL			
E = VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F = FLOW RATE	RATIO (FRACTION)			
G = USER'S CHOICE		GLASS, VIEWING DEVICE		
H = HAND				HIGH
I = CURRENT (ELECTRICAL)		INDICATE		
J = POWER	SCAN			
K = TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L = LEVEL		LIGHT		LOW
N = USER'S CHOICE	MOMENTARY			MIDDLE, INTERMEDIATE
N = USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O = USER'S CHOICE		ORIFICE, RESTRICTION		
P = PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q = QUANTITY	INTERGRATE, TOTALIZE			
R = RADIATION		RECORD		
S = SPEED, FREQUENCY	SAFETY		SWITCH	
T = TEMPERATURE			TRANSMIT	
U = MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V = VIBRATION, MECH. ANALYSIS			VALVE, DAMPER, LOUVER	
W = WEIGHT, FORCE		WELL		
X = UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y = EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z = POSITION, DIMENSION	Z AXIS		DRIVE, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

NOTES:
1. ANY FIRST LETTER COMBINED WITH MODIFIER REPRESENTS A NEW AND SEPARARE MEASURED VARIABLE. EXAMPLES: PD = DIFFERENTIAL PRESSURE FQ = TOTALIZED OR INTEGRATED FLOW. EXCEPTION IS THE MODIFIER "J" FOR MULTIPOINT SCANNING.
2. FOR ANALYSIS NOT IDENTIFIED BY A SPECIFIC LETTER IN THE TABLE, USE FIRST LETTER "A" NEAR THE INSTRUMENT SYMBOL, SPECIFY THE NATURE OF THE ANALYSIS. EXAMPLE: PH
3. MEANING OF A "USER CHOICE" LETTER SHALL BE CONSISTENT THROUGHOUT A PROJECT, AND SHALL BE SPECIFIED IN THE DRAWING LEGEND.
4. UNCLASSIFIED LETTER MAY HAVE A FEW DIFFERENT MEANINGS ON A PROJECT, THE MEANING SHALL BE SPCIFIED NEAR EACH INSTRUMENT SYMBOL USING THE UNCLASSIFIED LETTER.
5. THE MODIFIER "SCAN" APPLIES TO MULTIPOINT PRINTING INSTRUMENTS, SUCH AS CJRS (MULTIPOINT CONDUCTIVITY RECORDER WITH ALARM SWITCHES).

INSTRUMENT SYMBOLS



GENERAL NOTE:

1. FOR MECHANICAL SYMBOLS AND ADDITIONAL NOTES. SEE SHAW DRAWING NO. PID-LA (SHEET 1 OF 1)

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	01-2?-04	ISSUED FOR CONSTRUCTION	DVP	MLL

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DRAWN BY/DATE: LJ/10-29-03
CHECKED BY/DATE: HS
SHEET SIZE: D
REVISION: 1
SHEET 2 OF 2
DRAWING #: PID-LB
FILE #: 100770LEGEND_SHT

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PIPING & INSTRUMENTATION DIAGRAM
LEGEND SHEET
SHAW PROJECT# 100770

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